PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
VISHNU K. AGARWAL
GARO DERDERIAN
GURTEJ S. SANDHU
WEIMIN M. LI
MARK VISOKAY
CEM BASCERI
SAM YANG

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For: METHODS FOR FORMING AND INTEGRATED CIRCUIT STRUCTURES CONTAINING RUTHENIUM AND TUNGSTEN CONTAINING LAYERS

Confirmation No.: 9849

Group Art Unit: 2818

Examiner: David Vu

Atty. Dkt. No.: 2008.010100
(formerly 6047-53173)

Customer No.: 23720

APPEAL BRIEF

Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicants hereby submit this Appeal Brief to the Board of Patent Appeals and Interferences in response to the Final Office Action dated March 20, 2006. The Notice of Appeal was filed on June 20, 2006.

The Director is authorized to deduct the fee for filing this Appeal Brief ($500), or any additional fees under 37 C.F.R. §§ 1.16 to 1.21 required for any reason relating to this document, from Williams, Morgan & Amerson, P.C. Deposit Account No. 50-0786/2008.010100.

I. REAL PARTY IN INTEREST

The present application is owned by Micron Technology, Inc.

II. RELATED APPEALS AND INTERFERENCES

Applicants have also appealed the final rejection of patent application Serial No. 10/226,008, which is a divisional of this application

III. STATUS OF THE CLAIMS

Claims 1-15, 19, 30, 32, 33, 41, 42 and 66-70 are pending in the application. Claims 1-71 were originally filed with the application. Claims 43-58, 64, 65 and 71 were withdrawn from consideration pursuant to a restriction requirement dated June 20, 2001. Claims 72 and 73 were added in Applicants' Response to the Office Action dated October 4, 2002. Claims 59-63 and 72-73 were canceled by Examiner's Amendment in the Notice of Allowance issued March 24, 2003. Claims 16-18 were canceled in Applicants' Response to the Office Action dated April 18, 2005. Claims 20-29, 31 and 34-40 were canceled in Applicant's Response to the Office Action dated September 22, 2005. Claims 1-15, 19, 30, 32, 33, 41, 42 and 66-70 are at issue in this appeal and they are attached as Appendix A. Claims 1-15, 19, 30, 32, 33, 41, 42 and 66-70 were rejected in the Final Office Action issued on March 20, 2006. Claims 1-15, 19, 30, 32, 33, 41, 42 and 66-70 are the subject of the present appeal.

IV. STATUS OF AMENDMENTS

No amendments have been filed subsequent to the Final Office Action.

V. SUMMARY OF CLAIMED SUBJECT MATTER

In general, the present invention is directed to semiconductor devices and the fabrication thereof, and, more particularly, to ruthenium- and tungsten-containing electrically conductive layers and the formation and use thereof. There are ten independent claims at issue in the current appeal: claims 1, 6, 9, 14, 15, 30, 32, 33, 41 and 66.

Independent claim 1 is generally directed to a method of forming an enhanced-surface-area electrically conductive structure including the steps of providing a layer 12 containing ruthenium oxide, converting at least a portion of the ruthenium oxide in the layer 12 to ruthenium so as to produce a ruthenium-containing layer 16 having a rough surface and annealing the rough-surfaced ruthenium layer 16 in an oxidizing ambient to form passivated ruthenium in an outer portion of the rough-surfaced ruthenium layer 16. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 6 is generally directed to a method of forming an enhanced-surface-area electrically conductive structure including the steps of providing a layer 12 containing ruthenium oxide, converting at least a portion of the ruthenium oxide to ruthenium by heating the layer 12 in a reduced-pressure environment with a pressure of about 75 Torr or less so as to produce a layer 16 having a rough surface and annealing the portion of ruthenium oxide that is converted to ruthenium in an oxidizing ambient to form a passivated ruthenium portion. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 9 is generally directed to a method of forming an enhanced-surface-area electrically conductive structure including the steps of providing a layer 12 containing

ruthenium oxide, converting at least a portion of the ruthenium oxide to ruthenium by heating the layer 12 to at least about 500°C in a reduced-pressure environment with a pressure of about 75 Torr or less for a sufficient time so as to produce a layer 16 having a rough surface and annealing the portion of ruthenium oxide that is converted to ruthenium in an oxidizing ambient to form a passivated ruthenium portion. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 14 is generally directed to a method of forming an enhanced-surface-area electrically conductive structure including the steps of providing a layer 12 containing ruthenium oxide, converting the ruthenium oxide in the layer to ruthenium so as to produce a ruthenium-containing layer 16 having a rough surface and annealing the rough-surfaced ruthenium-containing layer 16 in an oxidizing ambient to form a passivated ruthenium portion. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 15 is generally directed to a method of forming an enhanced-surface-area electrically conductive structure including the steps of providing a layer 12 containing ruthenium oxide, converting some ruthenium oxide in the layer to ruthenium so as to produce a ruthenium-containing layer 16 having a rough surface with a mean feature size of at least about 100 Angstroms and exposing the layer 16 having a rough surface to an oxidizing ambient. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 30 is generally directed to a method of forming an enhanced-surface-area electrically conductive layer including the steps of providing a layer 12 containing ruthenium oxide, selecting anneal conditions adapted to convert at least a portion of the

ruthenium oxide to ruthenium, annealing the layer under the selected conditions so as to produce a layer 16 having a rough surface and passivating the annealed layer by exposing the annealed layer to an oxidizing ambient. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 32 is generally directed to a method of forming an enhanced-surface-area electrically conductive layer including the steps of forming a layer of conducting material, forming a layer 12 comprising ruthenium oxide on the layer of conducting material and annealing the layer 12 comprising ruthenium oxide so as to convert at least some of the ruthenium oxide to ruthenium so as to produce a layer 16 having a textured surface with a mean feature size of about 100 Angstroms or more. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 33 is generally directed to a method of forming an enhanced-surface-area electrically conductive layer including the steps of providing a layer 12 comprising ruthenium oxide, annealing the layer 12 comprising ruthenium oxide so as to convert at least some of the ruthenium oxide to ruthenium so as to produce a resulting layer 16 having a textured surface with a mean feature size of about 100 Angstroms or more and forming a layer 30 of electrically conductive material conformally over the resulting layer such that the surface of the conductive material away from the resulting layer 16 has a textured surface generally corresponding to that of the resulting layer 16. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; Figures 1-7.

Independent claim 41 is generally directed to a method of forming a capacitor including the steps of providing a first layer of electrically conductive material, forming a layer 12 containing ruthenium oxide on the layer of electrically conductive material, annealing the layer

12 containing ruthenium oxide so as to convert at least some of the ruthenium oxide to ruthenium and so as to produce a rough resulting surface with a mean grain size of at least about 100 Angstroms, forming a layer 28 of dielectric material over the layer 16 having a rough surface and forming a second layer 30 of conductive material over the layer of dielectric material. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; p. 8, l. 20 – p. 11, l. 19; Figures 1-9C.

Independent claim 66 is generally directed to a method of forming an array of capacitors including the steps of providing a layer 12 containing ruthenium oxide, converting at least some of the ruthenium oxide to ruthenium so as to produce a resulting layer 16 having a rough surface, forming a layer 28 of dielectric material over the resulting layer 16, forming a conductive layer 30 on the layer of dielectric material 28 and defining an array of electrodes by patterning at least one of the ruthenium oxide layer 12 or the resulting layer 16. By way of example only, at least portions of the invention are described at p. 2, l. 31 – p. 4, l. 18; p. 5, l. 11 – p. 9, l. 7; p. 8, l. 20 – p. 11, l. 19; Figures 1-9C.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1-5, 14, 15, 19 and 30 stand rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by Tanaka (U.S. Patent No. 6,355,492).

2. Claims 6-13 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Tanaka in view of Yamauchi (U.S. Patent No. 6,284,587).

3. Claims 32, 33, 41, 42 and 66-69 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Tanaka.

4. Claim 70 stands rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Tanaka in view of Kiyotoshi (U.S. Patent No. 6,091,099).

VII. ARGUMENT

A. Legal Standards

As the Board well knows, an anticipating reference by definition must disclose every limitation of the rejected claim in the same relationship to one another as set forth in the claim. *In re Bond*, 15 U.S.P.Q.2d 1566, 1567 (Fed. Cir. 1990). To the extent the Examiner relies on principles of inherency in making the anticipation rejections in the Office Action, inherency requires that the asserted proposition necessarily flow from the disclosure. *In re Oelrich*, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981); *Ex parte Levy*, 17 U.S.P.Q.2d 1461, 1463-64 (Bd. Pat. App. & Int. 1990); *Ex parte Skinner*, 2 U.S.P.Q.2d 1788, 1789 (Bd. Pat. App. & Int. 1987); *In re King*, 231 U.S.P.Q. 136, 138 (Fed. Cir. 1986). It is not enough that a reference could have, should have, or would have been used as the claimed invention. "The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Oelrich*, at 326, quoting *Hansgirg v. Kemmer*, 40 U.S.P.Q. 665, 667 (C.C.P.A. 1939); *In re Rijckaert*, 28 U.S.P.Q.2d 1955, 1957 (Fed. Cir. 1993), quoting *Oelrich*, at 326; see also *Skinner*, at 1789. "Inherency … may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Skinner*, at 1789, citing *Oelrich*. Where anticipation is found through inherency, the Office's burden of establishing prima facie anticipation includes the burden of providing "…some evidence or scientific reasoning to establish the reasonableness of the examiner's belief that the functional limitation is an inherent characteristic of the prior art." *Skinner* at 1789.

Moreover, to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991); M.P.E.P. § 2142. Moreover, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. 580 (CCPA 1974). If an independent claim is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988); M.P.E.P. § 2143.03.

With respect to alleged obviousness, there must be something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination. *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561 (Fed. Cir. 1986). In fact, the absence of a suggestion to combine is dispositive in an obviousness determination. *Gambro Lundia AB v. Baxter Health-care Corp.*, 110 F.3d 1573 (Fed. Cir. 1997). The mere fact that the prior art can be combined or modified does not make the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d 1430 (Fed. Cir. 1990); M.P.E.P. § 2143.01. The consistent criterion for determining obviousness is whether the prior art would have suggested to one of ordinary skill in the art that the process should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art. Both the suggestion and the expectation of success must be founded in the prior art, not in the Applicant's

disclosure. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991; *In re O'Farrell*, 853 F.2d 894 (Fed. Cir. 1988); M.P.E.P. § 2142.

B. Claims 1-5, 14, 15, 19 and 30 are Not Anticipated by Tanaka

Independent claims 1, 14, 15 and 30 and dependent claims 2-5 and 19 stand rejected as being anticipated by Tanaka. Respectfully, the Examiner erred in making these rejections.

Tanaka is directed to a method of forming a capacitor and the resulting structure. Abstract; Col. 1, ll. 10-14. Tanaka specifically notes that the use of metals, such as ruthenium (Ru), as a capacitor plate may cause problems when it is oxidized. Col. 2, ll. 12-27. To that end, Tanaka is directed to a method of forming a metal oxide layer by oxidizing a surface of a metal layer on the basis of a diffusion controlled reaction. Col. 2, ll. 44-46. In Example 1, Tanaka discloses forming a metal oxide layer by heat treating a previously formed metal layer. Col. 6, ll. 20-43. According to Tanaka, ruthenium oxide powder is reduced in a nitrogen environment to obtain Ru single crystal powder. The Ru single crystal powder is then heated to form a metal oxide layer. Col. 6, ll. 36-43. In Example 3, Tanaka discloses forming a lower metal oxide layer 22A of ruthenium by a deposition process. Thereafter, the metal layer 22A is oxidized to form the metal oxide layer 22B. Col. 9, ll. 1-45; Figures 4A-4B

Independent claim 1 is fundamentally different from the methods disclosed in Tanaka. Claim 1 requires providing a layer containing ruthenium oxide and converting at least a portion of the ruthenium oxide in the ruthenium oxide layer to ruthenium to produce a ruthenium-containing layer having a rough surface. Independent claims 14, 15 and 30 contain similar limitations. Tanaka does not disclose or suggest the methodology defined by the pending independent claims.

Tanaka is concerned with the oxidation of a ruthenium layer when the ruthenium layer is used as an electrode of a capacitor. Col. 2, ll. 12-27. To alleviate the problems, Tanaka proposes a unique method whereby a "surface of a metal layer is oxidized on the basis of a diffusion-controlling reaction, to form a metal oxide layer, so that a dense metal oxide layer can be formed." Col. 15, ll. 31-34 (emphasis added). Further, the metal oxide layer is formed at the interface to an insulation layer of a capacitor so that the flatness of the electrode surface is not impaired by evaporation and/or re-oxidation when the electrode is exposed to a high temperature. Col. 15, ll. 34-39.

Tanaka does not disclose or suggest converting at least a portion of a previously formed layer of ruthenium oxide to ruthenium, as recited in claim 1. In Tanaka, the **REVERSE** process is happening. The layer of ruthenium 22A is oxidized so as to form a ruthenium oxide layer 22B. See Figure 4B. Moreover, as understood by the undersigned, the process described in Tanaka is an effort to insure that "the flatness of the electrode surface is not at all impaired by evaporation and/or re-oxidation...." Col. 15, ll. 34-37 (emphasis added). In contrast, claim 1 recites that the method claimed therein results in "a ruthenium-containing layer having a rough surface" (emphasis added).

Respectfully, there appears to be some confusion as it relates to the Examiner's understanding or characterization of the disclosure of Tanaka. In making the anticipation rejection of the above claims, the Examiner stated "Tanaka discloses a method of forming a ruthenium capacitor electrode (col. 2, lines 9-12) by reducing ruthenium oxide layer under a nitrogen gas at 1773K to obtain a Ru layer having an average particle diameter of about 100,000 Å...." Final Office Action, pp. 2-3. However, later in the Final Office Action, the Examiner states "Tanaka fails to disclose the Ru lower electrode is formed by converting the ruthenium

oxide to ruthenium layer." Final Office Action, p. 5 (emphasis added). As understood by the undersigned, these two statements made by the Examiner are directly contrary to one another.

Tanaka either does or does not show the process of converting ruthenium oxide to ruthenium. On pages 2-3 of the Final Office Action, the Examiner asserts that Tanaka does disclose this limitation to support the anticipation rejection of claims 1-5, 14, 15, 19 and 30. Yet, on page 5 of the Final Office Action, the Examiner asserts that Tanaka does not disclose conversion of ruthenium oxide to ruthenium.

It is respectfully submitted that a plain reading of Tanaka clearly shows that Tanaka DOES NOT disclose the conversion of ruthenium oxide to ruthenium as set forth in independent claims 1, 14, 15 and 30.

For at least the aforementioned reasons, it is respectfully submitted that the Examiner erred in rejecting claims 1-5, 14, 15, 19 and 30 as being anticipated by Tanaka. The anticipation rejection of dependent claims 4-5 and 19 is equally flawed due to the erroneous rejection of independent claims 1 and 15. Accordingly, the Examiner's anticipation rejection of claims 1-5, 14, 15, 19 and 30 should be REVERSED.

C. Claims 6-13, 32, 33, 41, 42 and 66-70 Are Not Obvious in View of the Art of Record

All of the § 103 rejections issued by the Examiner are based upon Tanaka as the primary reference. Applicants respectfully submit that the Examiner erred in making the § 103 rejections.

Independent claims 6, 9,32, 33, 41 and 66 were rejected as allegedly being obvious. Each of these independent claims contain the limitation regarding conversion of ruthenium oxide to ruthenium, as discussed above with respect to the anticipation rejection of independent claim 1.

Of course, the Board will need to consult the exact language employed in each claim, as each of these independent claims is of differing scope.

First, as noted above, Tanaka fails to disclose many fundamental aspects of the presently claimed invention. Thus, even if the references were combined in the manner suggested by the Examiner, such a combination of prior art would not contain <u>all</u> the limitations set forth in the claims. The citations to the various secondary references cannot cure the fundamental deficiencies in Tanaka, as noted above. Accordingly, any such obviousness rejection would be legally improper for at least this reason.

Moreover, it appears that Tanaka <u>teaches away</u> from the presently claimed inventions in at least three respects. First, in Tanaka, as it relates to the <u>layers</u> of material, *i.e.*, not the powders, Tanaka teaches oxidizing a surface of a ruthenium layer to form a metal oxide layer. It is not understood why one skilled in the art, when reading the express disclosure of Tanaka, would be motivated to form a <u>layer</u> of ruthenium oxide and <u>convert</u> at least a portion of the ruthenium oxide in that <u>layer</u> to ruthenium. That is directly <u>contrary</u> and <u>opposite</u> to what Tanaka teaches. Simply put, why would one skilled in the art read Tanaka and be motivated to act <u>contrary</u> and <u>opposite</u> to the express teachings of Tanaka.

Second, it is unclear that the device in Tanaka could function for its intended purpose as an electrode for a capacitor if, as the Examiner suggests, the metal layer 22A in Figure 4B was actually a metal oxide layer, and the metal oxide layer 22B was actually a metal layer. It would appear that such a "modified structure" might not work as an electrode for a capacitor.

Third, it appears that Tanaka is directed to a process that is intended to <u>maintain or not degrade</u> (Tanaka uses the phrase "not impair") the <u>flatness</u> of the gate electrode. Col. 15, ll. 35-37. All of the pending independent claims call for the resulting surface of the layer to have a

rough surface (claims 1, 6, 9, 14, 15, 30, 41 and 66) or a specifically defined textured surface (claims 32, 33). Again, there does not appear to be any logical reason why one skilled in the art would be motivated to modify the teachings of Tanaka (a capacitor-electrode with a surface wherein the flatness is "not impaired") for a ruthenium-containing layer that has a rough surface or textured surface, as recited in the pending claims.

A recent Federal Circuit case makes it crystal clear that, in an obviousness situation, the prior art must disclose each and every element of the claimed invention, and that any motivation to combine or modify the prior art must be based upon a suggestion in the prior art. *In re Lee*, 61 U.S.P.Q.2d 143 (Fed. Cir. 2002). Conclusory statements regarding common knowledge and common sense are insufficient to support a finding of obviousness. *Id.* at 1434-35. It is respectfully submitted that the Examiner's assertion that the invention defined by the pending independent claims would have been obvious in view of Tanaka and the prior art of record constitutes an impermissible use of hindsight using Applicants' disclosure as a roadmap. "Our case law makes clear that the best defense against the subtle but powerful attraction of hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references." *Telefex v. KSR Intern. Co.*, 119 Fed. Appx. 282 (Fed. Cir. 2005) (unpublished) (citations omitted).

Accordingly, it is respectfully requested that the Examiner's obviousness rejection of claims 6-13, 32, 33, 41, 42 and 66-70 be REVERSED.

VIII. CLAIMS APPENDIX

The claims that are the subject of the present appeal – claims 1-15, 19, 30, 32, 33, 41, 42 and 66-70 – are set forth in the attached "Claims Appendix."

IX. EVIDENCE APPENDIX

Applicants do not rely upon any evidence as indicated on the attached Evidence Appendix.

X. RELATED PROCEEDINGS APPENDIX

There are no Related Proceedings for this appeal as indicated on the attached Related Proceedings Appendix.

XI. CONCLUSION

Accordingly, it is respectfully submitted that the Examiner erred in not allowing claims 1-15, 19, 30, 32, 33, 41, 42 and 66-70 over the prior art of record. Applicants respectfully request the Board REVERSE the Examiner's rejections. The undersigned attorney may be contacted at (713) 934-4055 with respect to any questions, comments or suggestions relating to this appeal.

Respectfully submitted,

WILLIAMS, MORGAN & AMERSON
CUSTOMER NO. 23720

Date: August 21, 2006

/J. Mike Amerson/

J. Mike Amerson
Reg. No. 35,426
10333 Richmond, Suite 1100
Houston, Texas 77042
(713) 934-4055
(713) 934-7011 (facsimile)

ATTORNEY FOR APPLICANTS

CLAIMS APPENDIX

1. A method of forming an enhanced-surface-area electrically conductive structure, the method comprising:

providing a layer containing ruthenium oxide;

converting at least a portion of the ruthenium oxide in the layer to ruthenium so as to produce a ruthenium-containing layer having a rough surface; and

annealing the rough-surfaced ruthenium layer in an oxidizing ambient to form passivated ruthenium in an outer portion of the rough-surfaced ruthenium layer.

2. The method of claim 1 wherein the act of converting comprises heating the layer.

3. The method of claim 1 wherein the act of converting comprises exposing the layer to a reducing ambient.

4. The method of claim 1 wherein the act of converting comprises exposing the layer to a reduced-pressure environment.

5. The method of claim 1 wherein the step of converting comprises converting at least a portion of the ruthenium oxide in the layer to ruthenium so as to produce a layer having a textured surface with a mean feature size of at least about 100 Angstroms.

6. A method of forming an enhanced-surface-area electrically conductive structure, the method comprising:

providing a layer containing ruthenium oxide;

converting at least a portion of the ruthenium oxide to ruthenium by heating the layer in a reduced-pressure environment with a pressure of about 75 torr or less so as to produce a layer having a rough surface; and

annealing the portion of ruthenium oxide that is converted to ruthenium in an oxidizing ambient to form a passivated ruthenium portion.

7. The method of claim 6 wherein the step of converting is performed in a reduced-pressure environment with a pressure of about 20 torr or less.

8. The method of claim 6 wherein the step of converting is performed in a reduced-pressure environment with a pressure of about 5 torr or less.

9. A method of forming an enhanced-surface-area electrically conductive structure, the method comprising:

providing a layer containing ruthenium oxide;

converting at least a portion of the ruthenium oxide to ruthenium by heating the layer to at least about 500°C in a reduced-pressure environment with a pressure of about 75 torr or less for a sufficient time so as to produce a layer having a rough surface; and

annealing the portion of ruthenium oxide that is converted to ruthenium in an oxidizing ambient to form a passivated ruthenium portion.

10. The method of claim 9 wherein the act of converting is performed by heating the layer to at least about 750°C.

11. The method of claim 9 wherein the act of converting is performed by heating the layer to at least about 800°C.

12. The method of claim 9 wherein the act of converting is performed by heating the layer to at least about 500°C for at least about 2 minutes.

13. The method of claim 9 wherein the act of converting is performed by heating the layer to at least about 500°C for a time in the range of about 2 to about 20 minutes.

14. A method of forming an enhanced-surface-area electrically conductive structure, the method comprising:

providing a layer containing ruthenium oxide;

converting the ruthenium oxide in the layer to ruthenium so as to produce a ruthenium-containing layer having a rough surface; and

annealing the rough-surfaced ruthenium-containing layer in an oxidizing ambient to form a passivated ruthenium portion.

15. A method of forming an enhanced-surface-area electrically conductive structure, the method comprising:

providing a layer containing ruthenium oxide;

converting some ruthenium oxide in the layer to ruthenium so as to produce a ruthenium-containing layer having a rough surface with a mean feature size of at least about 100 Angstroms; and

exposing the layer having a rough surface to an oxidizing ambient.

19. The method of claim 15 wherein the act of exposing comprises exposing the layer having a rough surface to a nitrogen-supplying reducing ambient and then to the oxidizing ambient.

30. A method of forming an enhanced-surface-area electrically conductive layer, the method comprising:

providing a layer containing ruthenium oxide;

selecting anneal conditions adapted to convert at least a portion of the ruthenium oxide to ruthenium;

annealing the layer under said conditions so as to produce a layer having a rough surface; and

passivating the annealed layer by exposing the annealed layer to an oxidizing ambient.

32. A method of forming an enhanced-surface-area electrically conductive layer, the method comprising:

forming a layer of conducting material;

forming a layer comprising ruthenium oxide on the layer of conducting material; and

annealing the layer comprising ruthenium oxide so as to convert at least some of the ruthenium oxide to ruthenium so as to produce a layer having a textured surface with a mean feature size of about 100 Angstroms or more.

33. A method of forming an enhanced-surface-area electrically conductive layer, the method comprising:

providing a layer comprising ruthenium oxide;

annealing the layer comprising ruthenium oxide so as to convert at least some of the ruthenium oxide to ruthenium so as to produce a resulting layer having a textured surface with a mean feature size of about 100 Angstroms or more; and

forming a layer of electrically conductive material conformally over the resulting layer such that the surface of the conductive material away from the resulting layer has a textured surface generally corresponding to that of the resulting layer.

41. A method of forming a capacitor, the method comprising:

providing a first layer of electrically conductive material;

forming a layer containing ruthenium oxide on the layer of electrically conductive material;

annealing the layer containing ruthenium oxide so as to convert at least some of the ruthenium oxide to ruthenium and so as to produce a rough resulting surface with a mean grain size of at least about 100 Angstroms;

forming a layer of dielectric material over the layer having a rough surface; and

forming a second layer of conductive material over the layer of dielectric material.

42. The method of claim 41 wherein the act of forming a layer of dielectric material comprises forming a layer of high-dielectric-constant dielectric material.

66. A method of forming an array of capacitors, the method comprising:

providing a layer containing ruthenium oxide;

converting at least some of the ruthenium oxide to ruthenium so as to produce a resulting layer having a rough surface;

forming a layer of dielectric material over the resulting layer;

forming a conductive layer on the layer of dielectric material; and

defining an array of electrodes by patterning at least one of the ruthenium oxide layer or the resulting layer.

67. The method of claim 66, wherein the array of electrodes is defined prior to forming the layer of dielectric material.

68. The method of claim 66, wherein the array of electrodes is defined after forming the conductive layer on the dielectric layer.

69. The method of claim 66, wherein the array of electrodes is defined by etching.

70. The method of claim 66, wherein the array of electrodes is defined by chemical-mechanical polishing.

EVIDENCE APPENDIX

Applicants do not rely on any evidence for this appeal.

RELATED PROCEEDINGS APPENDIX

There are no Related Proceedings for this appeal